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which can produce such marked and unfavorable results in a herd protected as carefully as that in the Bieloviejska forest. The factors which have brought about this decrease may be divided into two principal categories: first, those wholly external; and second, those proceeding from the animals themselves. Under the first head are discussed: hunting, poaching, taking of live specimens for zoological gardens, ravages of beasts of prey and of various diseases, and finally possible deaths from shortage of food supply. As all these factors taken together are shown to be insufficient to account for the present condition of the herd, the true reason must be sought in the animals themselves. As long ago as 1830 Jarocki noticed that the bison cows as a rule calve only once in three years, and this observation has been repeatedly verified. The question at once arises whether this low grade of fertility is natural or otherwise. A careful study of the breeding habits of the bison in the Bieloviejska forest and elsewhere leaves no room for doubt that the present slow rate of reproduction is an abnormal condition, and that to it is due the rapid approach of the extinction which is the certain fate of the herd under consideration. This diminished fertility the author regards as a stigma of degeneration caused by in-breeding. Associated with it are other stigmata, such as fatty degeneration of various organs and abnormal condition in parts of the skeleton. Many of the bison cows are known to be wholly unable to care for their calves through lack of milk. The process of degeneration has progressed so far that the more degenerate animals may be recognized by their paler color, weaker horns and thinner fur. Of eleven captured by Strahlborn in 1858, four were of the pallid, thin-haired, degenerate type. Another indication of the degenerate condition of the Bieloviejska herd is seen in the great

excess of bulls, which probably outnumber the cows two to one. This is doubtless a result of in-breeding, for Düsing (Jena Zeitschr. für Naturwiss, Bd. XVII., p. 827, 1884) has shown that close in-breeding, like a reduced condition of nutrition, is favorable to the production of an excess of males. Thus the total extinction of the Bieloviejska bison is certain to occur, and that probably in the near future. Such a fate the author points out overtook the last herd of *Bos primigenius* in Poland during the early part of the seventeenth century, notwithstanding the most careful protection.

In conclusion, the author considers that his studies of the history of the Bieloviejska bison leave scarcely room for doubt that in-breeding is the cause of the final extinction of most large mammals. In-breeding must begin and lead gradually but certainly to the extinction of a species when it, through any cause, has become so reduced in numbers as to be separated into isolated colonies.

If Büchner's conclusion is correct—and few will doubt that it is—we may look for the speedy extinction of the American bison, whatever means may be taken for the protection of the few remaining individuals, while the danger attending any considerable reduction in the size of the Pribilof Island seal colonies, with the expectation that they will regain their former size under subsequent strict protection, becomes fully apparent.

GERRIT S. MILLER, JR.

IDENTIFICATION OF LEMURS AND THE SYSTEMATIC POSITION OF *TARSIVUS*.

IN a recent number of SCIENCE appeared an abstract by Prof. A. A. W. Hubrecht, of his contribution to Gegenbaur's *Festschrift*, giving his conclusions upon the relations of Lemurs and monkeys, especially upon the position of *Tarsivus* among the Anthropoidea. It is interesting to find, in the same collection of memoirs, a contribution from

Prof. Wilhelm Leche, of the University of Stockholm, upon the teeth of living and extinct Lemurs, in which different conclusions are reached.

He sums up his results as follows: "The observations brought together in the preceding sections include a number of facts which are of general significance and which may be of general service. During the Eocene and Oligocene periods, Europe and North America were inhabited by groups of Lemurs, which contained a number of genera distributed in both hemispheres. During the Oligocene every trace of these Lemurs disappeared in the northern hemisphere, and we find no traces of these animals until they reappear among the existing forms of the Ethiopian and Indian regions. To our complete ignorance of the Lemurs during the long intermediate period is added the fact that at first sight the modern Lemurs appear to be a group widely different genetically from those of Eocene times. Yet, as I have endeavored to demonstrate above, the difference between the living and extinct Lemurs is by no means so great as it is generally supposed to be. Among the old Tertiary forms the strong differentiation of the teeth in the anterior portion of the jaw, which characterizes the living forms, had not arisen. Yet even in these older forms we see certain indications which point towards such a differentiation. Notably supporting such a conclusion are the discoveries in the milk dentition of weight.

"Until we obtain further knowledge, as above stated, we must distinguish two groups of extinct Lemurs, the most complete representatives of which are *Adapis* and *Microchaerus*.* In spite of all the differences between these two groups, there are, nevertheless, exhibited a number of common characters, in which they together

appear to present a more primitive constitution than any of the living Lemurs. To select a single illustration, among the older tertiary Lemurs we still find four premolars and three upper incisors, while in the living forms we never find more than three premolars and two upper incisors.*

"Among the living forms we have certainly to distinguish two groups, the *Lemuridae* and *Tarsiidae*, the latter uniting most closely with *Microchoerus* and its related forms. Now, while the modern *Tarsius*, in important parts of its structure—in the structure of its placenta, in the structure of its orbit and in the straight colon—certainly has taken a different developmental direction from the remaining Lemurs and deserves an isolated position, nevertheless, its milk dentition shows such a close approach to that of the true Lemurs that a common derivation of the *Lemuridae* and *Tarsiidae* must be considered as at least highly probable. For the hypothesis which I have endeavored to establish in my earlier work, that the milk teeth are to be regarded as the representatives of an earlier developmental phase, with more primitive characters than the permanent teeth, we find that the teeth of the Lemurs lend a number of supporting features: First, in *Hapalemur* the superior incisors have a more normal position in the milk dentition than in the permanent dentition. Second, the second upper premolar of *Adapis* has retained the original premolar form more completely than its permanent successor. Third, the lower incisors of the Lemurs are somewhat less modified than their successors. Fourth, the second lower premolar of the Lemurs has, as is well known, taken on the form of a canine, while the milk tooth correspondent to this retains the more ancient premolar form. Fifth, in the *Indrisinae* and in *Chiromys* the milk dentition retains almost

*Prof. Leche considers *Necrolemur* Filhol. as equivalent to this form.

*Prof. Leche has evidently overlooked *Anaptomorphus*.

the complete typical formula, while the permanent dentition shows a very marked reduction. Also in *Lepidolemur*, in which all the superior permanent incisors are wanting, one incisor is preserved in the milk dentition.

"Almost without exception the milk teeth of the Lemurs are smaller and weaker than the corresponding permanent teeth. If the permanent dentition reaches a higher grade than the dentition it is explained by the fact, as I have already shown, that the latter has undergone a more or less pronounced differentiation in the size of its individual components; this is the case in *Tarsius*, *Indrisinae* and *Chiromys*, without in the least diminishing the original number of the teeth.

"So far as I have considered the phylogeny of the different teeth, whilst among the Insectivora and the mammalia of the secondary period, and in exceptional cases among the living forms such as the Marsupial *Choeropus* and the fossil *Paleochoerus*, canines are observed with double roots—a character which is certainly to be regarded as primitive—I have found in the Lemurs, both in the milk and permanent dentition, two-rooted canines. The fact that often a one-rooted milk canine is replaced by a two-root permanent canine, and this order in other cases is reversed, requires further clearing up.

"That an elongate or more premolar-like structure of the superior canine is the original form of this tooth in the Lemurs, appears to be evident in every case in which the permanent canine differs from the milk canine; for the milk tooth is always more like a premolar than the permanent tooth, as seen in the comparison of *Chirogaleus*, *Adapis* and *Tarsius*. A comparison of the canine of the old tertiary form, *Microchoerus*, with that of the modern *Tarsius*, lead us to the same results."

H. F. O.

CURRENT NOTES ON PHYSIOGRAPHY.

ORIGIN OF THE LAURENTIAN RIVER SYSTEM.

UPHAM continues his discussion of the great lake problem (*Amer. Geol.*, XVIII., 1896, 169–177), maintaining that during Tertiary time the Mississippi-St. Lawrence divide probably lay northwest of the Adirondacks, in this differing from Spencer, who regards the preglacial St. Lawrence as already an extensive river system. Certain general relations of our larger land forms and river systems would, however, seem to prove the extension of the preglacial St. Lawrence at least into the Ontario basin. All the Great Lakes, except Superior, lie along the inner lowlands, and are enclosed by the infacing uplands* of an ancient and greatly denuded coastal plain of paleozoic strata, whose oldland is the Laurentian highland. The great Appalachian valley is also an inner lowland, between the inface of the Alleghany and Cumberland plateau and the oldland of the Blue Ridge; but this inner lowland is complicated by the mountains that have been bent up and worn down along it. The normal drainage of both these regions would be from the oldland across the inner lowland and out through the scarped uplands to the Ohio or Mississippi. The Wisconsin and the Kanawha rivers are exceptional in still preserving this normal course. The Potomac, Susquehanna, Delaware and Hudson are all abnormal in flowing from the Alleghany plateau across the inner lowland and out through the oldland to the Atlantic. Now, as these abnormal courses had been attained in early Tertiary time, and perhaps sooner, it is not only possible, but probable, that a considerable part of the abnormal drainage area of the St. Lawrence had been developed much earlier than Upham maintains.

* The Spanish term *cuesta* might be used for this unnamed form. See Hill, *Nat. Geog. Mag.*, VII., 1896, 295.